WHAT IS CLAIMED IS

1. A turbo-reception method of receiving a signal from N transmitters where N is an integer equal to or greater than 2, comprising the steps of

calculating a channel value $h_{mn}(q)$ and a channel matrix **H** from M received signals r_m(where M is an integer equal to or greater than 1) and a known signal, where m=1, ⋯, M; n=1, ⋯, N and q=0, ⋯, Q-1, and Q represents a number of multipaths of each transmitted wave;

determining a soft decision transmitted symbol $b'_n(k)$ from N a priori information $\lambda_2\,[b_n(k)]$ where k represents a discrete time;

using the channel value $h_{mn}(q)$ and the soft decision transmitted symbol $b'_n(k)$, calculating an interference component $\mathbf{H}\cdot\mathbf{B}'(k)$ upon a transmitted signal from an n-th transmitter,

where

$$\mathsf{H}=\begin{bmatrix} \mathsf{H}_{(0)} & \cdots & \mathsf{H}_{(Q-1)} & & 0 \\ & \ddots & & \ddots & \\ 0 & & \mathsf{H}_{(0)} & \cdots & \mathsf{H}_{(Q-1)} \end{bmatrix}$$

$$\mathsf{H}_{(q)}=\begin{bmatrix} h_{11(q)} & \cdots & h_{1N(q)} \\ \vdots & \ddots & \vdots \\ h_{M1(q)} & \cdots & h_{MN(q)} \end{bmatrix}$$

$$\mathbf{B}'(k)=[\mathbf{b}'^{T}(k+Q-1)\ldots\mathbf{b}'^{T}(k)\ldots\mathbf{b}'^{T}(k-Q+1)]^{T}$$

$$\mathbf{b}'(k+q)=[b'_1(k+q)b'_2(k+q)\ldots b'_N(k+q)]^{T}$$

$$q=Q-1\ldots\ldots-Q+1 \quad q\neq 0$$

$$\mathbf{b}'(k)=[b'_1(k)\ldots 0\ldots b'_N(k)]^{T} \qquad q=0$$

$\mathbf{b}'(k)$ having a zero element at an n-th position and $[\ ]^{T}$ representing a

transposed matrix;

subtracting the interferenced component $\mathbf{H}\cdot\mathbf{B}'(k)$ from a received matrix $\mathbf{y}(k)$ to obtain a difference matrix $\mathbf{y}'(k)$ where

$$\mathbf{y}(k)=[\mathbf{r}^T(k+Q-1)\mathbf{r}^T(k+Q-2)\ldots\mathbf{r}^T(k)]^T$$
$$\mathbf{r}(k)=[r_1(k)r_2(k)\ldots r_M(k)]^T$$

using the channel matrix $\mathbf{H}$ or a reference signal to determine an adaptive filter coefficient $\mathbf{w}_n(k)$ which is to be applied to a received signal corresponding to a transmitted signal from an n-th transmitter in order to eliminate residual interference components in the difference matrix $\mathbf{y}'(k)$;

and filtering the difference matrix $\mathbf{y}'(k)$ with the adaptive filter coefficient $\mathbf{w}_n(k)$ to provide a log-likelihood ratio for the received signal which corresponds to the transmitted signal from the n-th transmitter and from which interferences are eliminated.

2. A turbo-reception method according to Claim 1 in which denoting a covariance matrix of noise components in the received matrix $\mathbf{y}(k)$ by U, using the soft decision transmitted symbol $b'_n(k)$ and the channel matrix $\mathbf{H}$ to calculate the adaptive filter coefficient $\mathbf{w}_n(k)$ according to the following formula:

$$\mathbf{w}_n(k)=(\mathbf{H}\mathbf{G}(k)\mathbf{H}^H+U)^{-1}\mathbf{h}$$
$$\mathbf{G}(k)=\mathrm{diag}[\mathbf{D}(k+Q-1)\ldots\mathbf{D}(k)\ldots\mathbf{D}(k-Q+1)]$$
$$\mathbf{D}(k+q)=\mathrm{diag}[1-b'^2_1(k+q),\ldots,1-b'^2_n(k+q),\ldots,1-b'^2_N(k+q)]$$
$$q=Q-1\ldots-Q+1, q\neq0$$
$$=\mathrm{diag}[1-b'^2_1(k+q),\ldots,1,\ldots,1-b'^2_N(k+q)] \qquad q=0$$

$$
h = \begin{bmatrix} H_{1,(Q-1)\cdot N+n} \\ H_{2,(Q-1)\cdot N+n} \\ \vdots \\ H_{M,(Q-1)\cdot N+n} \end{bmatrix}
$$

where $\mathbf{H}_{1,(Q-1)\cdot N+n}$ represents an element of the matrix **H** located at row 1 and column (Q-1)N+n .

3. A turbo-reception method of receiving a signal from N transmitters where N is an integer equal to or greater than 2, comprising the steps of

calculating a channel value $h_{mn}(q)$ and a channel matrix **H** from M received signals r_m where M is an integer equal to or greater than 1 and where m is 1, ⋯,M; n=1, ⋯. N; q=0, ⋯, Q-1, and Q represents a number of multipaths of each transmitted wave;

determining a soft decision transmitted symbol $b'_n(k)$ from N a priori information $\lambda_2\,[b_n(k)]$ where k represents a discrete time;

using the channel value $h_{mn}(q)$ and the soft decision transmitted symbol $b'_n(k)$ to calculate an interference component $\mathbf{H}\cdot\mathbf{B}'(k)$ upon a transmitted signal from the n-th transmitter where

$$
H = \begin{bmatrix} H_{(0)} & \cdots & H_{(Q-1)} & & 0 \\ & \ddots & & \ddots & \\ 0 & & H_{(0)} & \cdots & H_{(Q-1)} \end{bmatrix}
$$

$$
H_{(q)} = \begin{bmatrix} h_{11(q)} & \cdots & h_{1N(q)} \\ \vdots & \ddots & \vdots \\ h_{M1(q)} & \cdots & h_{MN(q)} \end{bmatrix}
$$

$$\mathbf{B}'(k)=[\mathbf{b}'^T(k+Q-1)\ldots\mathbf{b}'^T(k)\ldots\mathbf{b}'^T(k-Q+1)]^T$$

$$\mathbf{b}'(k+q)=[b'_1(k+q)b'_2(k+q)\ldots b'_N(k+q)]^T$$

$$q=Q-1\ldots\ldots-Q+1 \quad q\neq 0$$

$$\mathbf{b}'(k)=[b'_1(k)\ldots-f(b'_n(k))\ldots b'_N(k)]^T \quad q=0$$

$\mathbf{b}'(k)$ having an element $f(b'_n(k))$ at an n-th position, f ( ) being a function of a variable $b'_n(k)$ and satisfying that $f(0) = 0$ and $d\{f(b'_n(k))\}/d\{b'_n(k)\}\geq 0$, and $[\,]^T$ representing a transposed matrix;

subtracting the interference component $\mathbf{H}\cdot\mathbf{B}'(k)$ from a received matrix $\mathbf{y}(k)$ to determine a difference matrix $\mathbf{y}'(k)$ where

$$\mathbf{y}(k)=[\mathbf{r}^T(k+Q-1)\mathbf{r}^T(k+Q-2)\ldots\mathbf{r}^T(k)]^T$$

$$\mathbf{r}(k)=[r_1(k)r_2(k)\ldots r_M(k)]^T$$

using the channel matrix $\mathbf{H}$ or reference signal to determine an adaptive filter coefficient $\mathbf{w}_n(k)$ which is to be applied to a received signal corresponding to the transmitted signal from the n-th transmitter in order to eliminate residual interference components which remain in the difference matrix $\mathbf{y}'(k)$;

and filtering the difference matrix $\mathbf{y}'(k)$ with the adaptive filter coefficient $\mathbf{w}_n(k)$ to provide a log-likelihood ratio for the received signal which corresponds to the transmitted signal from the n-th transmitter and from which interferences are eliminated.

4. A turbo-reception method according to Claim 3, further comprising, denoting a covariance matrix of noise components in the received matrix $\mathbf{y}(k)$ by U, using the soft decision transmitted symbol $b'_n(k)$ and a channel matrix $\mathbf{H}$ to calculate the adaptive filter coefficient $\mathbf{w}_n(k)$ according to

the following formula:

$$\mathbf{w}_n(k)=(\mathbf{H}\mathbf{G}(k)\mathbf{H}^H+U)^{-1}\mathbf{h}$$

$$\mathbf{G}(k)=\mathrm{diag}[\mathbf{D}(k+Q-1)\ldots\mathbf{D}(k)\ldots\mathbf{D}(k-Q+1)]$$

$$\mathbf{D}(k+q)=\mathrm{diag}[1-b'^2_1(k+q),\ldots,1-b'^2_n(k+q),\ldots,1-b'^2_N(k+q)]$$
$$q=Q-1\ldots-Q+1,q\neq 0$$
$$=\mathrm{diag}[1-b'^2_1(k+q),\ldots,1-b'^2_{n-1}(k),1+2E[f(b'_n(k)]+E[f(b'_n(k)^2],$$
$$1-b'^2_{n+1}(k),\ldots,1-b'^2_N(k+q)] \quad q=0$$

where E[ ] represents a mean value, and

$$h=\begin{bmatrix} H_{1,(Q-1)\cdot N+n} \\ H_{2,(Q-1)\cdot N+n} \\ \vdots \\ H_{M,(Q-1)\cdot N+n} \end{bmatrix}$$

where $\mathbf{H}_{1,(Q-1)\cdot N+n}$ represents an element of the matrix **H** at row 1 and a column (Q-1) N+n.

5. A turbo-reception method according to Claim 2 or 4 in which an inverse matrix calculation during the calculation of the adaptive filter coefficient $\mathbf{w}_n(k)$ takes place by using matrix inversion lemma.

6. A turbo-reception method according to Claim 1 or 2 in which the covariance matrix U of noise components in the received matrix **y** (k) is defined as σ^2 **I** which is determined by a variance σ^2 of a Gaussian distribution and a unit matrix.

7. A turbo-reception method according to Claim 1 or 2 in which

the covariance matrix U of noise components in the received matrix **y** (k) is derived, using the received matrix **y**(k) and the estimated channel matrix **H**, as follows:

$$\hat{U} = \Sigma_{k=0}^{Tr}(\mathbf{y}(k)-\hat{\mathbf{H}}\cdot\mathbf{B}(k))\cdot(\mathbf{y}(k)-\hat{\mathbf{H}}\cdot\mathbf{B}(k))^{H}$$

$$\mathbf{B}(k)=[\mathbf{b}^{T}(k+Q-1)\ldots\mathbf{b}^{T}(k)\ldots\mathbf{b}^{T}(k-Q+1)]^{T}$$

$$\mathbf{b}(k+q)=[b_1(k+q)\ldots b_N(k+q)]^{T}$$

$$(q=-Q+1\ldots Q-1)$$

where Tr represents the length of the reference signal.

8. A turbo-reception method according Claim 2 or 3 in which D(k+q) is approximated by 0 for $q\neq0$, and D(k+q) is approximated by diag [0, ⋯,1, ⋯, 0] for q=0.

9. A turbo-reception method of receiving a signal from N transmitters where N is an integer equal to or greater than 2, comprising the steps of

calculating a channel value $h_{mn}(q)$ and a channel matrix **H** from M received signals r_m (where M is an integer equal to or greater than 1) and a known signal where m=1, ⋯, M ; n=1, ⋯, N; q=0, ⋯, Q-1, and Q represents a number of multipaths of each transmitted wave;

determining a soft decision transmitted symbol $b'_n(k)$ from N a priori information $\lambda_2[b_n(k)]$ where k represents a discrete time;

using the channel value $h_{mn}(q)$ and the soft decision transmitted symbol $b'_n(k)$ to calculate an interference component $\mathbf{H}\cdot\mathbf{B}'(k)$ upon a transmitted signal from an n-th transmitter where

$$\mathsf{H}=\begin{bmatrix} \mathsf{H}_{(0)} & \cdots & \mathsf{H}_{(Q-1)} & & 0 \\ & \ddots & & \ddots & \\ 0 & & \mathsf{H}_{(0)} & \cdots & \mathsf{H}_{(Q-1)} \end{bmatrix}$$

$$\mathsf{H}_{(q)}=\begin{bmatrix} h_{11(q)} & \cdots & h_{1N(q)} \\ \vdots & \ddots & \vdots \\ h_{M1(q)} & \cdots & h_{MN(q)} \end{bmatrix}$$

$$\mathbf{B}'(k)=[\mathbf{b}'^{T}(k+Q-1)\ldots\mathbf{b}'^{T}(k)\ldots\mathbf{b}'^{T}(k-Q+1)]^{T}$$

$$\mathbf{b}'(k+q)=[b'_1(k+q)b'_2(k+q)\ldots b'_N(k+q)]^{T}$$

$$q=Q-1\ldots\ldots-Q+1 \quad q\neq 0$$

$$\mathbf{b}'(k)=[b'_1(k)\ldots 0\ldots b'_N(k)]^{T} \quad q=0$$

$\mathbf{b}'(k)$ having a zero element at an n-th position and $[\ ]^{T}$ representing a transposed matrix;

subtracting the interference component $\mathbf{H}\cdot\mathbf{B}'(k)$ from a received matrix $\mathbf{y}(k)$ to determine a difference matrix $\mathbf{y}'(k)$ where

$$\mathbf{y}(k)=[\mathbf{r}^{T}(k+Q-1)\mathbf{r}^{T}(k+Q-2)\ldots\mathbf{r}^{T}(k)]^{T}$$

$$\mathbf{r}(k)=[r_1(k)r_2(k)\ldots r_M(k)]^{T}$$

defining a covariance matrix of noise components in the received matrix $\mathbf{y}(k)$ as $\sigma^2\,\mathbf{I}$ which is determined from a variance σ^2 of a Gaussian distribution and a unit matrix $\mathbf{I}$, and filtering the difference matrix $\mathbf{y}'(k)$ with an adaptive filter coefficient $\mathbf{w}_n$ which is determined by

$$h = \begin{bmatrix} H_{1,(Q-1)\cdot N+n} \\ H_{2,(Q-1)\cdot N+n} \\ \vdots \\ H_{M\cdot Q,(Q-1)\cdot N+n} \end{bmatrix}$$

to provide a log-likelihood ratio for the received signal which corresponds to the transmitted signal from the n-th transmitter and from which interferences are eliminated.

10. A turbo-reception method of receiving a signal from N transmitters where N is an integer equal to or greater than 2, comprising the steps of

calculating a channel value $h_{mn}(q)$ and a channel matrix $\mathbf{H}$ from M received signals r_m (where M is an integer equal to or greater than 1) and a known signal where $m=1, \cdots, M$; $n=1, \cdots, N$; $q=0, \cdots, Q-1$, and Q represents a number of multi paths of each transmitted wave;

determining a soft decision transmitted symbol $b'_n(k)$ from N a priori information $\lambda_2[b_n(k)]$ where k represents a discrete time;

calculating an interference component $\mathbf{H}\cdot\mathbf{B}'(k)$ upon a transmitted signal from an n-th transmitter using the channel value $h_{mn}(q)$ and the soft decision transmitted symbol $b'_n(k)$ as follows:

$$\mathbf{H}=\begin{bmatrix} \mathbf{H}_{(0)} & \cdots & \mathbf{H}_{(Q-1)} & & 0 \\ & \ddots & & \ddots & \\ 0 & & \mathbf{H}_{(0)} & \cdots & \mathbf{H}_{(Q-1)} \end{bmatrix}$$

$$\mathbf{H}_{(q)}=\begin{bmatrix} h_{11(q)} & \cdots & h_{1N(q)} \\ \vdots & \ddots & \vdots \\ h_{M1(q)} & \cdots & h_{MN(q)} \end{bmatrix}$$

$$\mathbf{B}'(k)=[\mathbf{b}'^T(k+Q-1)\ldots\mathbf{b}'^T(k)\ldots\mathbf{b}'^T(k-Q+1)]^T$$

$$\mathbf{b}'(k+q)=[b'_1(k+q)b'_2(k+q)\ldots b'_N(k+q)]^T$$

$$q=Q-1\ldots\ldots-Q+1 \quad q\neq 0$$

$$\mathbf{b}'(k)=[b'_1(k)\ldots-f(b'_n(k))\ldots b'_N(k)]^T \quad q=0$$

where $\mathbf{b}'(k)$ has an element $f(b'_n(k))$ at an **n**-th position, f( ) is a function of a variable $b'_n(k)$ which satisfies that of $f(0)=0$ and is $d\{f(b'_n(k))\}/d\{b'_n(k)\} \geq 0$ and $[\ ]^T$ is a transposed matrix;

subtracting the interference component $\mathbf{H}\cdot\mathbf{B}'(k)$ from a received matrix $\mathbf{y}(k)$ to define a difference matrix $\mathbf{y}'(k)$ where

$$\mathbf{y}(k)=[\mathbf{r}^T(k+Q-1)\mathbf{r}^T(k+Q-2)\ldots\mathbf{r}^T(k)]^T$$

$$\mathbf{r}(k)=[r_1(k)r_2(k)\ldots r_M(k)]^T$$

defining a covariance matrix for noise components in the received matrix $\mathbf{y}(k)$ as $\sigma^2\mathbf{I}$ which is determined from a variance σ^2 of a Gaussian distribution and unit matrix $\mathbf{I}$, and filtering the difference matrix $\mathbf{y}'(k)$ with an adaptive filter coefficient $\mathbf{w}_n(k)$ which is determined by

$$h=\begin{bmatrix} H_{1,(Q-1)\cdot N+n} \\ H_{2,(Q-1)\cdot N+n} \\ \vdots \\ H_{M\cdot Q,(Q-1)\cdot N+n} \end{bmatrix}$$

to provide a log-likelihood ratio for the received signal which corresponds to the transmitted signal from the n-th transmitter and from which interferences are eliminated.

11. A turbo-reception method of receiving a transmitted signal from N transmitters where N is an integer equal to or greater than 2 comprising the steps of

determining a channel value which is a transmission characteristic of a received signal from M received signals (where M is an integer equal to or greater than 1) and a known signal;.

estimating a soft decision transmitted symbol each from N a priori information;

dividing N transmitted signals each into L (L≤N) groups of transmitted signals including one or a plurality of transmitted signals, using a soft decision transmitted symbol and a channel matrix comprising channel values to determine L equalized signals from which interferences from other group of transmitting signals are eliminated and post-equalization channel information each corresponding to the transmission characteristic of the equalized signal for each group of transmitted signals;

for each combination of L equalized signals and associated channel information, treating the group of equalized signals as a received signal having a channel value defined by the channel information and where there is

a plurality of transmitted signals which constitute the group of equalized signals, dividing such transmitted signal into a plurality of sub-group of one or a plurality of transmitted signals, using the soft decision transmitted signal to determine an equalized signal for the subgroup of transmitted signals from which interferences from the other groups of transmitted signals are eliminated and associated post-equalization channel information, and where the group comprises a single transmitted signal, using the resulting equalized signal, the channel information and the soft decision transmitted signal to eliminate an interference of the transmitted signal itself due to multipaths;

repeating the steps of dividing, eliminating interferences and generating post-equalization channel information until transmitted signals which constitute every equalized signal becomes a single one, thus finally determining a equalized signal for each transmitted signal from which an interference caused by multipaths of its own is eliminated or determining, for the combination of the equalized signal and associated channel information, an equalized signal from which an interference between different transmitted signals and an intersymbol interference by the transmitted signal itself is eliminated for each transmitted signal which constitutes the equalized signal.

12. A turbo-reception method according to Claim 11, in which for each group of transmitted signals, using the soft decision transmitted symbol and the channel value to generate a replica of interferences caused by other groups of transmitted signals, subtracting the replica of interferences from the received signal to define a difference signal, determining, for each difference signal, a filter characteristic which is used to eliminate residual interference and associated post-equalization channel information from the channel value and the soft decision transmitted symbol, filtering a corresponding difference signal with the residual interference eliminating filter characteristic to derive

the equalized signal.

13. A turbo-reception method according to Claim 12, comprising the steps of

determining from the received signals $r_1(k), \cdots, r_M(k)$, a received matrix as defined below

$$\mathbf{y}(k)=[\mathbf{r}^T(k+Q-1)\mathbf{r}^T(k+Q-2)\ldots\mathbf{r}^T(k)]^T$$
$$\mathbf{r}(k)=[r_1(k)r_2(k)\ldots r_M(k)]^T$$

where $[\ ]^T$ represents a transposed matrix;

defining the transmission characteristic as a channel matrix **H** as defined below

$$\mathsf{H}=\begin{bmatrix} \mathsf{H}_{(0)} & \cdots & \mathsf{H}_{(Q-1)} & & 0 \\ & \ddots & & \ddots & \\ 0 & & \mathsf{H}_{(0)} & \cdots & \mathsf{H}_{(Q-1)} \end{bmatrix}$$

$$\mathbf{H}(q)=[\mathbf{h}_1(q)\ldots\mathbf{h}_N(q)]$$
$$\mathbf{h}_n(q)=[h_{1n}(q)\ldots h_{Mn}(q)]^T$$

where $m=1, \cdots, M$; $n=1, \cdots, N$; and $q=0, \cdots, Q-1$ and Q is a number of muti-paths, and $h_{mn}(q)$is a channel value of a path q from an n-th transmitter which is contained in the received signal r_m;

denoting the soft decision transmitted symbol by $b'_n(k)$, calculating a replica $\mathbf{H}\cdot\mathbf{B}'(k)$ upon one of groups of transmitted signals, formed by a first to a U-th transmitted signal where U is an integer satisfying $N>U\geq1$ caused by other groups of transmitted signals as follows;

$$\mathbf{B}'(k)=[\mathbf{b}'^T(k+Q-1)\ldots\mathbf{b}'^T(k)\ldots\mathbf{b}'^T(k-Q+1)]^T$$

$$\mathbf{b}'(k+q)=[b'_1(k+q)b'_2(k+q)\ldots b'_n(k+q)\ldots b'_N(k+q)]^T$$

$$:q=Q-1,\ldots 1$$

$$\mathbf{b}'(k+q)=[0\ldots 0\ b_{u+1}'(k+q)\ldots b'_N(k+q)]^T \quad :q=0,\ldots,-Q+1$$

where $\mathbf{b}'(k+q)$ have zero elements which are equal to U in number;

subtracting the interference replica $\mathbf{H}\cdot\mathbf{B}'(k)$ from the received matrix $\mathbf{y}(k)$ to define the difference matrix $\mathbf{y}'_g(k)$.

14. A turbo-reception method according to Claim 11 in which when a further elimination of interferences is desired for the equalized signal and associated channnel information, the number of multipaths which are used during the elimination of interferences from the equalized signal is reduced.

15. A turbo-reception method according to Claim 14, further comprising the steps of determining from the received signals $r_1(k), \cdots, r_M(k)$, a received matrix defined as follows;

$$\mathbf{y}(k)=[\mathbf{r}^T(k+Q-1)\mathbf{r}^T(k+Q-2)\ldots\mathbf{r}^T(k)]^T$$

$$\mathbf{r}(k)=[r_1(k)r_2(k)\ldots r_M(k)]^T$$

where $[\ ]^T$ represents a transposed matrix;

defining the transmission characteristic in the form of a channel matrix $\mathbf{H}$, defined as follows;

$$\mathrm{H}=\begin{bmatrix} \mathrm{H}_{(0)} & \cdots & \mathrm{H}_{(Q-1)} & & 0 \\ & \ddots & & \ddots & \\ 0 & & \mathrm{H}_{(0)} & \cdots & \mathrm{H}_{(Q-1)} \end{bmatrix}$$

$$\mathbf{H}(q)=[\mathbf{h}_1(q)\ldots\mathbf{h}_N(q)]$$

$$\mathbf{h}_n(q)=[h_{1n}(q)\ldots h_{Mn}(q)]^T$$

where m=1, ···, M; n=1, ···, N; and q=0, ···, Q-1 and Q is a number of mutipaths, and $h_{mn}(q)$is a channel value of a path q from an n-th transmitter which is contained in the received signal r_m;

denoting the soft decision transmitted symbol by $b'_n(k)$, one of the groups of transmitted signals comprising a first to U-th transmitted signal where U is an integer satisfying the inequality N>U≥1, an equalized signal being formed for this group of transmitted signals so that interferences therein are eliminated by considering a number of multipaths equal to Q′ where Q′<Q, calculating a replica of interference upon this group from other groups of transmitted in the form of $\mathbf{H}\cdot\mathbf{B}'(k)$ as follows;

$$\mathbf{B}'(k)=[\mathbf{b}'^T(k+Q-1)\ldots\mathbf{b}'^T(k)\ldots\mathbf{b}'^T(k-Q+1)]^T$$

$$\mathbf{b}'(k+q)=[b'_1(k+q)b'_2(k+q)\ldots b'_n(k+q)\ldots b'_N(k+q)]^T :q=Q-1,\ldots 1$$

$$\mathbf{b}'(k+q)=[0\ldots 0 \quad b'_{u+1}(k+q)\ldots b'_N(k+q)]^T :q=0,\ldots,-Q'+1$$

where $\mathbf{b}'(k+q)$ have 0 elements which are equal to U in number, and

$$\mathbf{b}'(k+q)=[b'_1(k+q)\ldots b'_n(k+q)\ldots b'_N(k+q)]^T :q=Q',\ldots,-Q+1$$

subtracting the interference replica $\mathbf{H}\cdot\mathbf{B}'(k)$ from the received matrix $\mathbf{y}(k)$ to define the difference matrix $\mathbf{y}'_g(k)$.

16. A time-reception method according to one of Claims 1, 3, 9, 10 and 11 in which during a second and a subsequent iteration of the turbo-reception processing, both the known singnal and the transmittes symbol hard decision output which is obtained during a previous alteration are used as reference signals, and the reference signals and the received signal are used to calculate the channel matrix.

17. A turbo-reception method according to Claim 16 in which one of the transmitted symbol hard decision outputs which are obtained during a

previous iteration and which has a certainty in excess of a given value is also used as a reference signal to be used in the calculation of the channel matrix.

18. A turbo-reception method according to one of Claims 1, 3, 9, 10 and 11 in which N a priori information λ_2 [$b_n(k)$] are derived from N decoders which correspond to the N transmitters, a log-likelihood ratio which is obtained for the received signal which corresponds to the n-th transmitted signal and through which interferences are eliminated is fed to a corresponding one of the decoders.

19. A turbo-reception method according to one of Claims 1, 3, 9, 10 and 11 in which the N transmitted signals are transmitted from N transmitters which transmit a single information series in the form of N parallel series, the N a priori information information λ_2 [$b_n(k)$] being a result of series-parallel converstion of a priori information λ_2 [b(j)] from one of the decoders, N log-likelihood ratios which are received signals corresponding to the N transmitted signals and from which interferences are eliminated being subject to a parallel-series convertion before being fed to the decoders.

20. A turbo-receiver for receiving a signal from N transmitters where N represents an integer equal to or greater than 2, comprising

a received signal generator for forming M received signals r_m (where M is an integer equal to or greater than 1) where m=1, ⋯, M;

a channel estimator to which each received signal r_m and a reference signal in the form of a known signal are input for calculating a channel value $h_{mn}(q)$ and a channel matrix **H**, as defined below

$$\mathbf{H} = \begin{bmatrix} \mathbf{H}_{(0)} & \cdots & \mathbf{H}_{(Q-1)} & & 0 \\ & \ddots & & \ddots & \\ 0 & & \mathbf{H}_{(0)} & \cdots & \mathbf{H}_{(Q-1)} \end{bmatrix}$$

$$\mathbf{H}_{(q)} = \begin{bmatrix} h_{11(q)} & \cdots & h_{1N(q)} \\ \vdots & \ddots & \vdots \\ h_{M1(q)} & \cdots & h_{MN(q)} \end{bmatrix}$$

$n=1, \dots N$

a received matrix generator which receives each received signal r_m for generating a received matrix, as defined below

$$\mathbf{y}(k)=[\mathbf{r}^T(k+Q-1)\ \mathbf{r}^T(k+Q-2)\dots\ \mathbf{r}^T(k)]^T$$
$$\mathbf{r}(k)=[r_1(k)\ r_2(k)\dots r_M(k)]^T$$

where k represents a discrete time, Q a number of multipaths of each transmitted wave, $q=0, \cdots, Q-1$, and $[\ ]^T$ representing a transposed matrix;

a soft decision symbol generator receiving N a priori information for generating a soft decision transmitted symbol $b'_n(k)$;

a replica matrix generator to which respective soft decision transmitted symbols $b_1'(k)$ to $b_N'(k)$ are input to generate an interference replica matrix **B'(k)** with respect to an n-th transmitted signal as follows;

$$\mathbf{B}'(k)=[\mathbf{b}'^T(k+Q-1)\dots\mathbf{b}'^T(k)\dots\mathbf{b}'^T(k-Q+1)]^T$$
$$\mathbf{b}'(k+q)=[b'_1(k+q)b'_2(k+q)\dots b'_N(k+q)]^T$$
$$q=Q-1,\dots,-Q+1\ ,\ q\neq 0$$
$$\mathbf{b}'(k)=[b'_1(k)\dots 0\dots b'_N(k)]^T \quad q=0$$

where $\mathbf{b}'(k)$ has a zero element at n-th position;

a filter processor to which the channel matrix $\mathbf{H}$ and the interference replica matrix $\mathbf{B}'(k)$ are input for calculating and delivering an interference component $\mathbf{H}\cdot\mathbf{B}'(k)$ with respect to a received signal corresponding to the n-th transmitted signal;

a difference calculator to which the interference component $\mathbf{H}\cdot\mathbf{B}'(k)$ and the received matrix $\mathbf{y}(k)$ are input for delivering a difference matrix $\mathbf{y}'(k) = \mathbf{y}(k) - \mathbf{H}\cdot\mathbf{B}'(k)$;

a filter coefficient estimator to which the channel matrix $\mathbf{H}$ or a reference signal is input for determining an adaptive filter coefficient $\mathbf{w}_n(k)$to be applied to a received signal which corresponds to a transmitted signal from the n-th transmitter in order to eliminate residual interference components which remain in the reference matrix $\mathbf{y}'(k)$;

and an adaptive filter to which the difference matrix $\mathbf{y}'(k)$ and the adaptive filter coefficient $\mathbf{w}_n(k)$ are input to filter $\mathbf{y}'(k)$ to provide a log-likelihood ratio as an received signal which corresponds to the transmitted signal from the n-th transmitter and from which interference is eliminated and which is then fed to the n-th decoder.

21. A turbo-receiver for receiving a signal from N transmitters where N is an integer equal to or greater than 2, comprising

a received signal generator for forming M received signals r_m (where M is an integer equal to or greater than 1) where m=1, ···, M;

N decoders;

a channel estimator to which each received signal r_m and a reference signal in the form of a known signal are input to calculate a channel value $h_{mn}(q)$ and a channel matrix $\mathbf{H}$, as defined below.

$$H = \begin{bmatrix} H_{(0)} & \cdots & H_{(Q-1)} & & 0 \\ & \ddots & & \ddots & \\ 0 & & H_{(0)} & \cdots & H_{(Q-1)} \end{bmatrix}$$

$$H_{(q)} = \begin{bmatrix} h_{11(q)} & \cdots & h_{1N(q)} \\ \vdots & \ddots & \vdots \\ h_{M1(q)} & \cdots & h_{MN(q)} \end{bmatrix}$$

$$n = 1, ..., N$$

a received matrix generator to which each received signal r_m is input to generate a received matrix, as defined below

$$\mathbf{y}(k)=[\mathbf{r}^T(k+Q-1)\mathbf{r}^T(k+Q-2)\ldots\mathbf{r}^T(k)]^T$$
$$\mathbf{r}(k)=[r_1(k)\, r_2(k)\ldots r_M(k)]^T$$

where k represents a discrete time, Q a number of multipaths of each transmitted wave, q=0, ···., Q-1 and [ ] ^{T} a transposed matrix;

a soft decision symbol generator to which N a priori information are input to generate soft decision transmitted symbols $b'_n(k)$ (where n=1, ···, N);

a replica matrix generator to which the soft decision transmitted symbols $b'_1(k)$ to $b'_n(k)$ are input to generate an interference replica matrix B'(k) for a transmitted signal from an n-th transmitter as indicated below

$$\mathbf{B}'(k)=[\mathbf{b}'^T(k+Q-1)\ldots\mathbf{b}'^T(k)\ldots\mathbf{b}'^T(k-Q+1)]^T$$
$$\mathbf{b}'(k+q)=[b'_1(k+q)b'_2(k+q)\ldots b'_N(k+q)]^T$$
$$q=Q-1,\ldots,-Q+1,\ q\neq 0$$
$$\mathbf{b}'(k)=[b'_1(k)\ldots -f(b'_n(k))\ldots b'_N(k)]^T \qquad q=0$$

where $\mathbf{b}'(k)$ has an element $f(b'_n(k))$ at an n-th position, and $f(\ )$ is a function of a variable $b'_n(k)$ which satisfies that $f(0)=0$ and

$$d\{f(b'_n(k))\}/\{b'_n(k)\}\geq 0;$$

a filter processor to which the channel matrix **H** and the interference replica matrix $\mathbf{B}'(k)$ are input to calculate and deliver an interference component $\mathbf{H}\cdot\mathbf{B}'(k)$ for a received signal which corresponds to the transmitted signal from the n-th transmitter;

a difference calculator to which the interference component $\mathbf{H}\cdot\mathbf{B}'(k)$ and the received matrix $\mathbf{y}(k)$ are input to deliver a difference matrix $\mathbf{y}'(k)=\mathbf{y}(k)-\mathbf{H}\cdot\mathbf{B}'(k)$;

a filter coefficient estimator to which the channel matrix **H** or a reference signal is input to determine an adaptive filter coefficient $\mathbf{w}_n(k)$ for a received signal which corresponds to a transmitted signal from the n-th transmitter in order to eliminate residual interferences in the difference matrix $\mathbf{y}'(k)$;

and an adaptive filter to which the difference matrix $\mathbf{y}'(k)$ and the adaptive filter coefficient $\mathbf{w}_n(k)$ are input to filter $\mathbf{y}'(k)$ to provide a log-likelihood ratio as a received signal which corresponds to the transmitted signal from the n-th transmitter and from which interferences are eliminated and which is then fed to the n-th decoder.

22. A turbo-receiver for receiving a transmitted signal from N transmitters where N is an integer equal to or greater than 2, comprising

a received signal generator for forming M received signals (where M is an integer equal to or greater than 1);

a channel estimator to which the N received signals and a reference signals in the form of a known signal are input to estimate a channel value representing a transmission characteristic;

a prestage equalizer to which the M received signals, the channel value and N a priori information are input for delivering, for each transmitted signal from one or more transmitters, a plurality of sets of equalized signal from which interferences by transmitted signals from other transmitters are eliminated and an associated post-equalization channel information;

and a plurality of poststage equalizers to which the set of the equalized signal and associated channel information from the prestage equalizer, and a priori information which corresponds to the transmitted signal which constitutes the equalized signal are input to deliver a log-likelihood ratio by eliminating from the equalized signal an intersymbol interference from each transmitted signal which constitutes the equalized signal due to the multiple paths and a mutual interferences between each transmitted signal and other transmitted signals which also constituted the equalized signal.

23. A turbo-receiver for receiving a transmitted signal from N transmitters where N is an integer equal to or greater than 2 , comprising

a received signal generator for forming M received signals (where M is an integer equal to or greater than 1);

a channel estimator to which the N received signals and a reference signal in the form of a known signal are input to estimate a channel value representing a transmission characteristic;

a prestage equalizer to which the M received signals, the channel value and N a priori information are input to deliver, for each transmitted signal from one or more transmitters, a plurality of sets of an equalized signal from which interferences by transmitted signals from other transmitters are eliminated and an associated post-equalization channel information;

and a plurality of poststage equalizers to which the sets of the equalized signal and associated channel information from the prestage

equalizer, and a priori information which corresponds to a plurality of transmitted signals which constitute the equalized signal are input to deliver, for each or for a sub-group of transmitted signals among the plurality of transmitted signals which constituted the equalized signals, a plurality of sets of an equalized signal from which interference by other transmitted signals which constituted that the equalized signals are eliminated and an associated post-equalization channel information.

24. A turbo-receiver according to one of Claims 20 to 23, further comprising a previous symbol memory in which a hard decision transmitted symbol from the decoder is stored to be updated, and means for reading the hard decision transmitted symbol from the previous symbol memory to feed it to the channel estimator as the reference signal during a second and a subsequent iteration of the turbo-reception processing.

25. A turbo-receiver according to Claim 24 further comprising a comparator for comparing a soft decision transmitted symbol which is input thereto against a threshold value, and a selector which is controlled by an output from the comparator so that one of the hard decision transmitted symbols, for which a corresponding soft decision transmitted symbol has a value in excess of the threshold value, is stored in the previous symbol memory.

26. A turbo-receiver according to one of Claims 20 to 23, further comprising N decoders, to which the N log-likelihood ratios are delivered, the N decoders providing the N a priori information at their outputs.

27. A turbo-receiver according to one of Claims 20 to 23 in which the N transmitted signals are transmitted signals as the N transmitters transmit a single information series as N parallel series, further comprising a parallel-series converter for converting the delivered N log-likelihood ratios

into serial series, a decoder to which the log-likelihood ratio in the serial series is input, and a series-parallel converter for converting a priori information from the decoder into N parallel series to provide the N a priori information.

28. A turbo-reception method in which a channel value representing a transmission path characteristic of a received signal is estimated from the received signal and a known signal serving as a reference signal, the received signal is processed in accordance with the estimated channel value, the processed signal is decoded, and the processing which uses the estimated channel value and the decoding are iterated upon the same received signal; further comprising

determining the certainty of a decoded hard decision information signal on the basis of a value of a corresponding soft decision information symbol, and using a hard decision information symbol having a certainty which is in excess of a given value in the channel estimation of a next iteration as a reference signal.

29. A reception method according to Claim 28, further comprising the step of calculating $\sigma^2 \mathbf{I}$ as a covariance matrix of noise component in a received matrix $\mathbf{y}(k)$ where σ^2 represents a variance of Gaussian distribution and $\mathbf{I}$ a unit matrix.

30. A reception method according to Claim 28 further comprising using an estimated channel matrix $\hat{\mathbf{H}}$ and a received signal matrix $\mathbf{y}(k)$ to calculate a covariance matrix U of noise components within the received signal matrix $\mathbf{y}(k)$ during each iteration as follows;

$$\hat{U}=\boldsymbol{\Sigma}_{k=0}{}^{Tr}(\mathbf{y}(k)-\hat{\mathbf{H}}\cdot\mathbf{B}(k))\cdot(\mathbf{y}(k)-\hat{\mathbf{H}}\cdot\mathbf{B}(k))^H$$

$$\mathbf{B}(k)=[\mathbf{b}^T(k+Q-1)\ldots\mathbf{b}^T(k)\ldots\mathbf{b}^T(k-Q+1)]^T$$

$$\mathbf{b}(k+q)=[b_1(k+q)\ldots b_N(k+q)]^T \quad (q=-Q+1\ldots Q-1)$$

b_1 (k+q) to b_N (k+q) being the reference signals comprising the known signal and the hard decision information symbols having a certainty which is in excess of a given value, Tr being the length of the reference signal.

31. A reception method according to Claim 28 in which the iteration of the processing which uses the estimated channel value and decoding processing comprises an iteration of determining a linear equalization filter in accordance with the estimated channel value, processing the received signal by the linear equalization filter and decoding the processed signal.

32. A reception method according to Claim 28 in which the iteration of the processing which uses the estimated channel value and decoding processing comprises an iteration of performing a rake synthesis which compensates for a phase rotation which each symbol has experienced on a transmission path in a rake synthesis processor in accordance with the estimated channel value, and decoding the signal which is produced by the rake synthesis in a turbo-decoder.

33. A reception method according to Claim 28 in which the iteration of the processing which uses the estimated channel value and decoding processing comprises an iteration of setting up weights which determine an antenna directivity response of an adaptive array antenna receiver in accordance with the estimated channel value, and decoding an output from the adaptive array antenna receiver in a turbo-decoder.

34. A reception method according to Claim 33 in which a rake synthesis which compensates for a phase rotation which each symbol has experienced on a transmission path in accordance with the estimated channel value is made for an output from the adaptive array antenna receiver in a rake synthesis processor, and a resulting signal from the rake synthesis is fed to the

turbo-decoder.

35. A receiver in which a channel value representing a transmission path characteristic of a received signal is estimated from the received signal and a known signal serving as a reference signal, the received signal is processed by using the estimated channel value, the processed signal is decoded, and the processing which uses the estimated channel value and the decoded processing are iterated upon the same received signal; further comprising

means for determining whether or not the certainty of a decoded hard decision information symbol is in the excess of a given value by seeing whether or not a corresponding soft decision information symbol has a value which is in excess of a threshold value;

and a previous symbol memory having its stored content updated by a hard decision information symbol which has been determined as likely to be certain, the stored content of the previous symbol memory being used as a reference signal during the channel estimation of a next ilteration.